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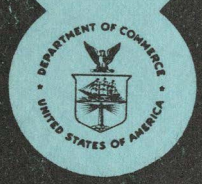

NOAA Technical Memorandum NWSTM PR-14

U.S. DEPARTMENT OF COMMERCE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
NATIONAL WEATHER SERVICE

TRADE WIND SPEED ESTIMATION AT SELECTED STATIONS ON OAHU USING HONOLULU WIND OBSERVATIONS, A PILOT STUDY

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PACIFIC REGION
HONOLULU, HAWAII
February 1976

NOAA TECHNICAL MEMORANDUM
National Weather Service, Pacific Region Subseries

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Dispersion
NWSTM PR-14

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LIST OF SYMBOLS

N...Barbers Point (Naval Air Station)

O...Hale Hoku Observatory

B...Bishop Point

H...Honolulu International Airport

K...Kalihi

Kaneohe...Kaneohe Marine Corps Air Station

n...normalized wind

A...actual wind speed at a particular station

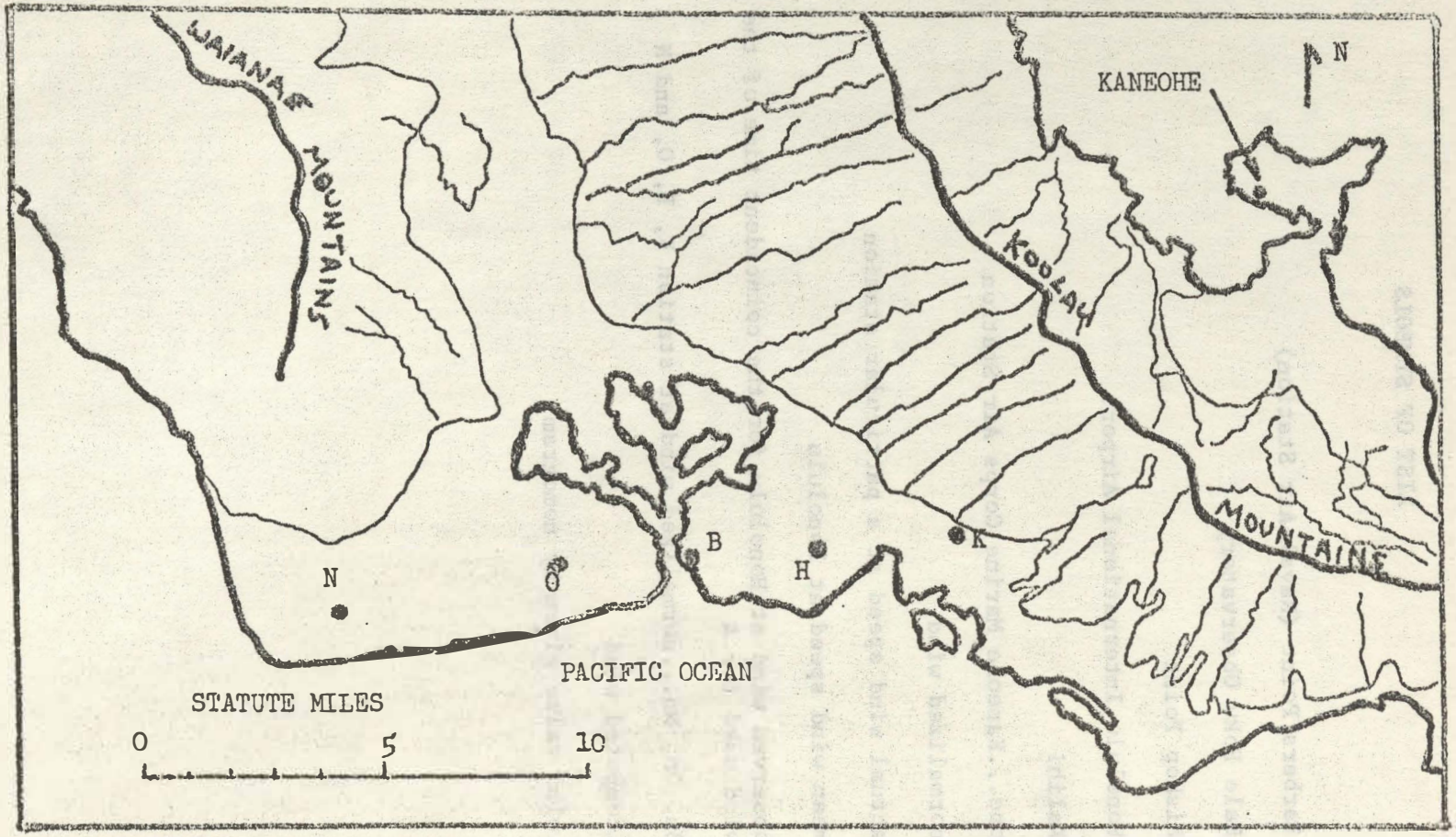
M...mean wind speed at Honolulu

R...observed wind at Honolulu for the coincident time of the wind used for A

Kn, Bn, On, Nn...normalized wind at station K, B, O, and N

Wc...computed wind

Vn...wind value given by nomogram



Map shows location of stations used in this monograph.

TRADE WIND SPEED ESTIMATION AT SELECTED STATIONS ON OAHU USING HONOLULU WIND OBSERVATIONS, A PILOT STUDY

I. INTRODUCTION

Wind is one atmospheric parameter which is difficult to predict. Over the ocean, fluctuations in the speed of the trade winds do not appear to be erratic: however, over the island of Oahu, as over the other large islands of Hawaii, trade wind speed varies greatly.

Local differences in terrain, distance from mountain ranges, station position in relation to mountain valleys and ridges, heights of vegetation, and man-made structures affect the wind speed.

This paper presents an empirical method for estimation of surface wind speeds at Barbers Point, Hale Hoku Observatory, Bishop Point, and Kalihi based on the observed wind speed at the Honolulu International Airport. (see list of symbols page i and the Map page ii for locations and formulae keys.)

An earlier NOAA Technical Memorandum NWSTM PR-12 by the writer, STRAIGHT LINE WIND VARIABILITY OVER SELECTED STATIONS ON LEEWARD OAHU, is the basis for the analysis brought forth in this monograph.

The primary station studied here is Barbers Point. This station was selected because surface wind data is plentiful and checking the results of an empirical formula is easily accomplished. An interesting adjunct to the stations selected above is the addition of Kaneohe Marine Corps Air Station, on the opposite side of the Koolau Mountains, which apparently follows the same empirical estimation as that obtained for Barbers Point.

II. PROCEDURE

The original data were normalized to Honolulu data by the simple formula $n = (A \times M)/R$. The original data--six observations from each location--as well as the normalized data appear below as table 1.

TABLE 1 (in knots)

K	B	O	N	Kn	Bn	On	Nn
6	6	0	6	5.3	5.0	0	6.0
4	8	0	3	3.0	10.0	0	4.1
10	6	0	3	13.6	9.0	0	3.8
6	10	6	7	5.6	10.0	5.0	6.2
9	8	6	9	7.9	7.1	5.3	7.5
6	11	6	12	6.9	16.5	6.9	13.8

The average of the Honolulu wind observations is 14.75 knots; however, fifteen knots has been used for the normalization process. The average of the normalized winds was found for each station. The standard deviation was then computed and is the basis for the limit of accuracy allowed for each station. Three knots becomes the limit for Barbers Point (also Kaneohe) and Hale Hoku Observatory. A four knot limit is set for Bishop Point and Kalihi in the same manner.

The normalized data were plotted and a nomogram made from the plots. Assessment of the nomogram implied two easily seen empirical formulae: (1) $Wc = H - 8 + Vn/2$, and (2) $Wc = 7 + Vn/2$. The assessment of speed is only for winds whose directions were 040 through 090 degrees, inclusive.

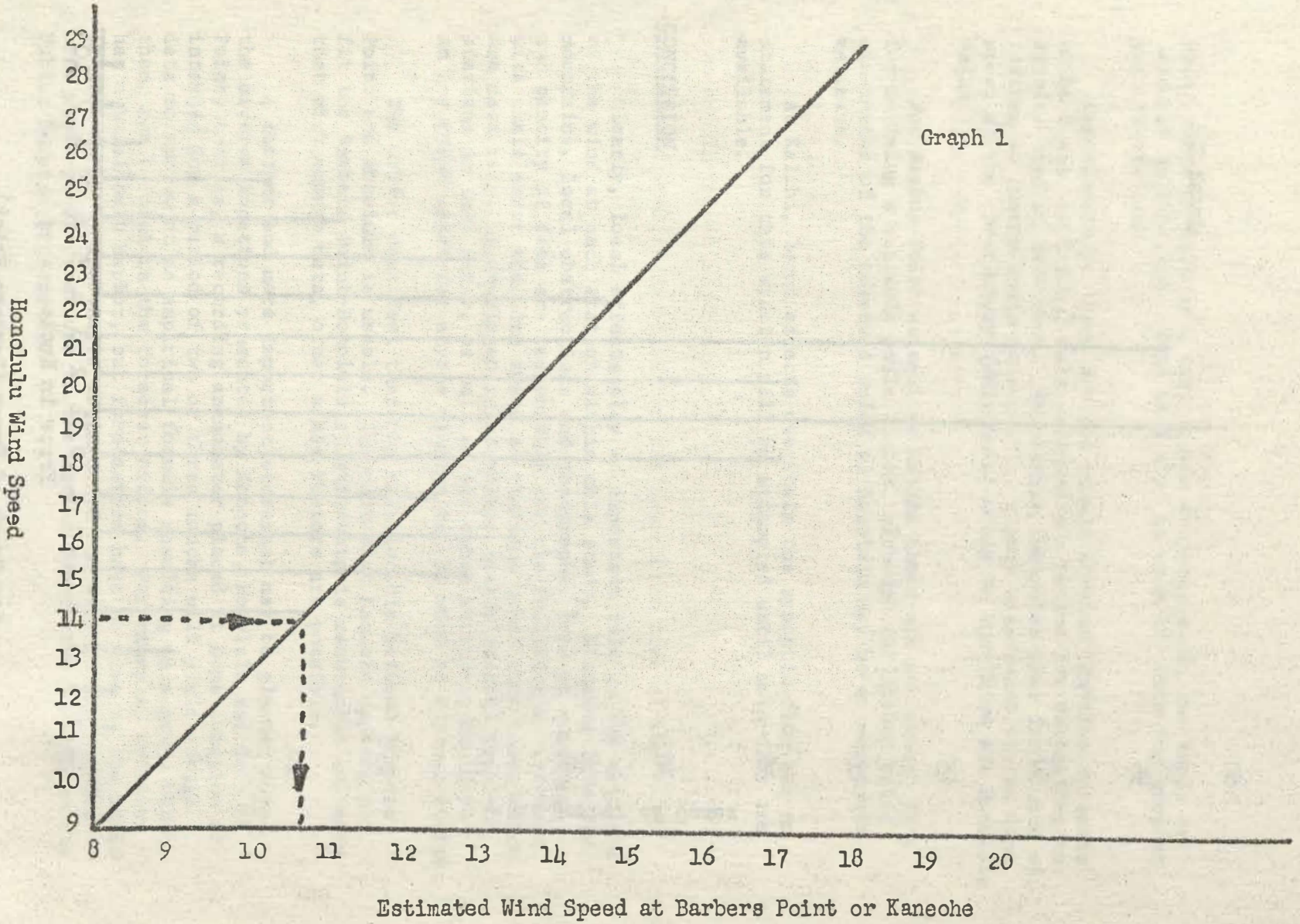
Upon checking the two formulae given above, it becomes evident very quickly that number one is not very good. Number two departs from the actual wind speed by three knots or less 72.6 percent of the 340 checks made for Barbers Point and 69.9 percent of the 316 checks made for Kaneohe. There are two restrictions, however: first, the upper limit is more or less dictated by the fact that the trade winds seldom reach an average speed of twenty-five or more knots in Honolulu, and, secondly, when the wind at Honolulu is eight knots or less a value of four knots will be accurate most of the time for Barbers Point. This was not checked for Kaneohe. The reader is cautioned that the empirical formula devised here is subject to local effects which may not, at present, be evaluated. Their role varies with the strength of the wind.

The Bar Graph of Error for Barbers Point presented on page 4 indicates a small adjustment is required to the empirical formulae used to bring the estimated wind closer to the observed wind;e however, the error is not deemed excessive.e

The end result for Barbers Point and Kaneohe is a graph which does away with the manipulating of the nomogram and allows direct reading of wind values for both stations. This is Graph 1 presented on page 3.

III. OTHER STATIONS ALONG THE LINE

A total of twenty-nine checkable observations were available for Hale Hoku, twenty-two of which are during the night. These twenty-two observations indicate calm wind at Hale Hoku. The remainder of the observations show five knots three times, six knots three times and ten knots once. The twenty-two observations of calm winds imply that eighty-two percent of the time an estimate of no wind at Hale Hoku (under trade wind conditions with fifteen knots or less at Honolulu) will be accurate.


Graph 1
Honolulu Wind Speed
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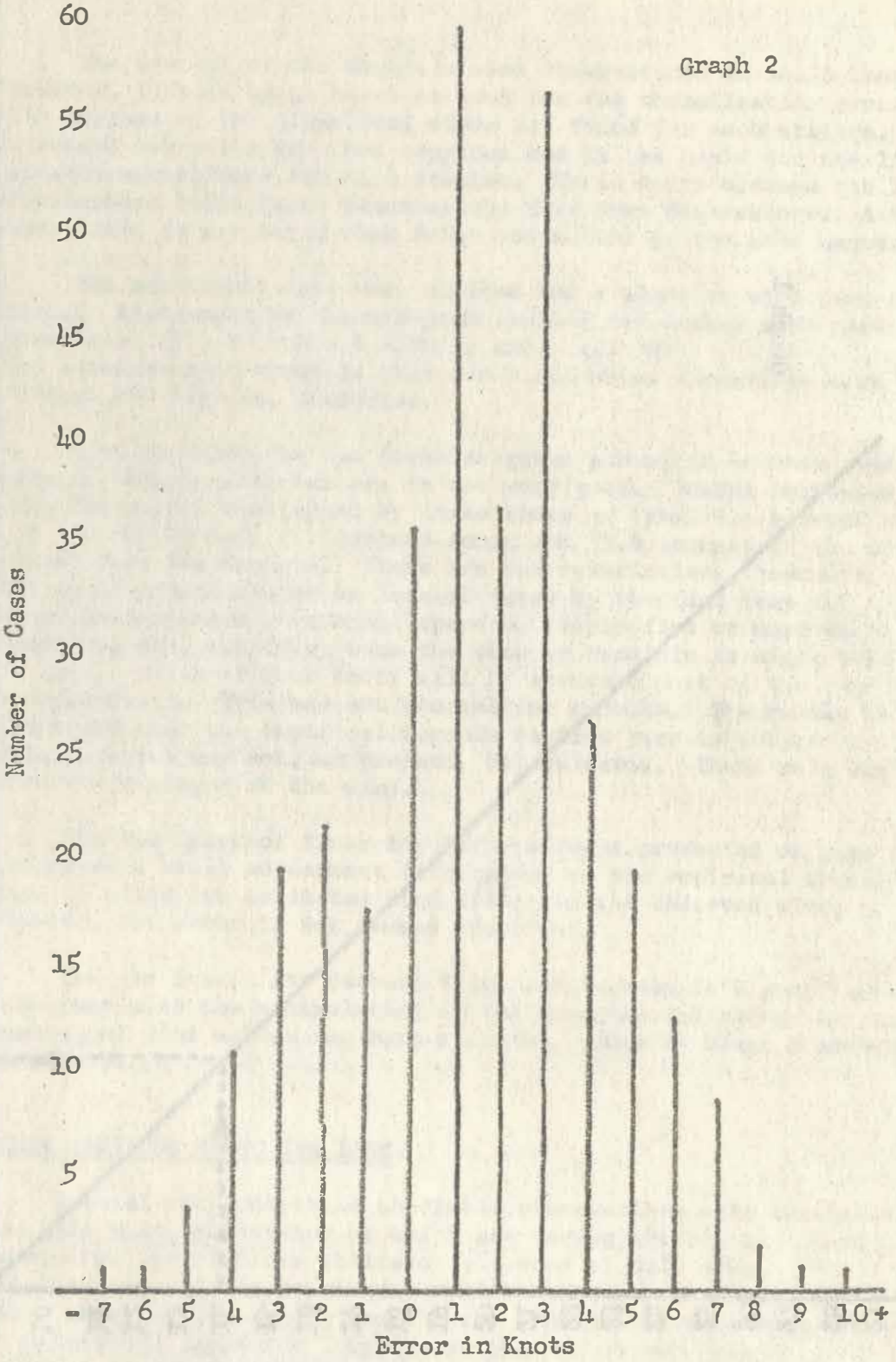
Estimated Wind Speed at Barbers Point or Kaneohe



Bar Graph of Error (Barbers Point)

Under these conditions a very gentle drainage wind, two knots or less, may be expected. This wind will be east of north the greater part of the time.

Unfortunately, there are not enough daytime (daytime is taken to be 8 a.m. to 8 p.m.) data to develop a method for estimating the daytime wind at Hale Hoku. Experience indicates that for a wind of fifteen to twenty knots at Honolulu, a good assessment of the wind speed at the observatory (Hale Hoku) would be one-third the Honolulu value.

For Bishop Point as well as Kalihi there are not enough data for deriving a suitable scale factor, although for Bishop Point six-tenths of the observed value at Honolulu may be a reasonable estimate.

At Kalihi, local effects overwhelm the synoptic flow and no statement for this station will be attempted until more data are available.

IV. CONCLUSION

Clearly, local effects play an important role in the variance of the wind at each station within this study. Distance from the mountains, local obstructions and topography, type of surface, and paucity of data are responsible for the inability to estimate with small error the wind speed at stations other than those which are data rich. A developed relationship (scale factor) from the stations in this paper, as well as for other stations, could be an important asset for anyone wishing to use wind as a power source.

The writer does feel that the relationship between Barbers Point and Honolulu is usable. The fact that Kaneohe appears to fit the Barbers Point-Honolulu relationship is reasonable evidence that with enough data, other scale factors are possible.

A further and more important statement may be gleaned from the diverse locations presented by Kaneohe, Honolulu and Barbers Point; that is, a recording anemometer placed at some location of interest for a period of two or three months will yield enough data to arrive at an empirical formula resulting in a graph which, then, can be used in the forecast office. For example, Haleiwa has a small boat harbor, but forecasters have no idea of the winds in that area. A reasonable estimate of the wind in the Haleiwa area would be of great use to the Marine Forecaster as well as the Public Service Forecaster.